09/763769
PRTS
Rec'd PCT/PTO 26 FEB 2001

TELECOMMUNICATION SYSTEM AS WELL AS A METHOD FOR THE OPERATION THEREOF

The invention is directed to a method for the operation of a telecommunication system according to the preamble of patent claim 1 and is also directed to a telecommunication system according to the preamble of patent claim 15. In particular, the invention is directed to a telecommunication system and a corresponding method wherein existing redundancies of data traffic units and clock handling units are advantageously established.

The term telecommunication is a collective designation for all message-oriented transmission methods with variously configured services in the communication over greater distances between man-man, man-machine and machine-machine. Telecommunication is receiving a rather particular significance due to the merging of information and communication technology. Telecommunication is characterized by the transmission technology with cable transmission technology, voice and data radio, satellite technology, light waveguide technology, modems, digital searching systems and switching technology and local networks.

In order to enable a meaningful message exchange between two (or more) partners, a controller is required in addition to the mere transmission of messages, said controller defining conventions in the form of protocols that must be adhered to for a meaningful communication. Such rules are, for example, described in the service specifications of the individual levels of the OSI reference model (Open Systems Interconnection). The OSI reference model was produced in the year 1983 by the International Standardization Organization (ISO) proceeding from the transmission of information in the sector of data processing and has become extremely wide-spread in the meantime, in applications of communication systems as well. The OSI model merely represents principles of the message transmission and consequently only defines the logic of the information flow between subscribers. Since the OSI standard contains no definitions about the physical transmission of communication, it is manufacturer-independent but needs supplementary protocols for

the realization of a communication system for a more detailed definition based on other, for example proprietary, standards.

Fundamentally, a distinction can be made between asynchronous and synchronous communication. What is generally understood by asynchronous communication is the exchange of messages between a transmission entity and a reception entity that is completely decoupled in terms of time. It cannot be predicted when a transmission operation and the appertaining reception operation will be initiated.

Compared thereto, what is understood by synchronous communication is the exchange of messages between a transmission entity and a reception entity when this exchange occurs in a fixed time grid. A transmission operation and the appertaining reception operation must thereby always be isochronically implemented.

Telecommunication networks are characterized by the possibility of bidirectional and multi-directional data exchange between the subscribers. This assumes that each participating subscriber can communicate with every other subscriber via the same medium. The simplest realization of this is communication of all subscribers in the base band. Due to the multitude of subscribers where active in parallel, it is mainly methods that statically allocate the available bandwidth to the subscribers in time-division multiplex that are utilized here.

Due to the increase in use of light waveguide technology, the necessity of an improved intercontinental data communication and the higher performance demands, the plesiochronic digital hierarchy (PDH) that has prevailed since the 1960's is being increasingly replaced by the synchronous digital hierarchy (SDH). The International Standard SDH enacted by the International Telecommunications Union (ITU) resulted from the American Standard SONET (Synchronous Optical Network), the standard that was developed by Bellcore in the USA and approved by the Industrial Carrier Compatibility Form (ICCF) in 1984.

Traditional telecommunication structures are based on time-division multiplex methods (TDM, time division multiplex). Compared thereto, ATM (asynchronous transfer mode) only sends data when this is required, i.e. frames are asynchronously transmitted. The initial recommendations for ATM were published in

the years 1990/91 and both the ITU as well as the ATM forum established in September 1991 have been concerned with the standardization of ATM.

Like other transmission methods, ATM is fundamentally based on a packet transmission technology. Similar to the OSI reference model, ATM is also vertically divided into several layers. Over and above this, a horizontal classification is undertaken according to aspects of the data exchange between users, aspects of the communication control and management aspects. A mapping of the individual ATM layers onto the layers of the OSI reference model is not possible without further ado since the functions of the ATM layers are partly distributed over different OSI layers. In OSI terminology, ATM would be resident on the bit transmission level but also offers some functions of the security level over and above this.

For the transmission, ATM only uses packets having a fixed length of 53 bytes. This rigid transmission unit is referred to as ATM cell and is composed of a header that is five bytes long as well as of 48 bytes of payload information (payload). UNI cells are distinguished from NNI cells dependent on the occupancy of the bits 5-8 of the first header byte.

In order to enable a step-by-step introduction of the ATM transmission method both in long-distance networks as well as in local networks, ATM is not bound to a specific transmission medium. The physical layer is therefore divided into a media-dependent sub-layer (PM) and a sub-layer (TC) that is independent of the transmission medium. The transmission of a cell thereby occurs in a continuous cell stream. A fixed allocation between virtual ATM channels and time slots of the medium does not exist. On the contrary, a plurality of time slots are dynamically allocated to each virtual channel in succession dependent on the required bandwidth. The asynchronism in ATM is therefore not comprised in a time-asynchronous access onto the transmission medium but in the dynamic assigning of the bandwidth useable for a virtual channel on the basis of the plurality of required time slots.

The direct transmission of ATM cells is the most efficient, since an additional overhead due to the adaptation to the transmission frame of the medium is eliminated, instead, the cell stream is directly transmitted bit-by-bit. The critical disadvantage of direct cell transmission is thereby comprised in the incapability with

previous transmission methods in long-distance networks, since the infrastructure of these networks is based mainly on PDH and SDH systems.

The transmission via SDH is based on the nesting of a plurality of ATM cells in the synchronous transport modules of the SDH hierarchy. The transmission of ATM cells via SDH has hitherto been specified for SDH transmission rates of 155 Mbps and 622 Mbps (STM-1 and STM-4). Over and above this, the use of the STM-16 hierarchy level with 2.5 Gbps is also provided.

Like an ATM transmission via SDH, the use of existing of PDH networks is also provided by the ITU. An ATM transmission via PDH hierarchy levels was standardized between 1.5 Mbps and 139 Mbps.

In telecommunication systems, circuits that are provided for the transmission, interpretation, formatting, handling and processing of payload and supplemental data are to be fundamentally distinguished from circuits that serve for the reception, the generation, modification, synchronization and forwarding of clock signals.

Telecommunication systems have the connection to standardized transmission networks like PDH, SDH or SONET usually require a synchronization in order to achieve the necessary quality at the interface to the transmission network. Two operating modes of the synchronization are thereby distinguished. In the case of an external synchronization, a clock is directly supplied to the system from an external synchronization. Compared thereto in a synchronization via the transmission path, the clock is acquired from the received data stream of the interface and supplied to the system as synchronization source. To this end, the received data frames also include supplemental information that describe the quality of the clock signal of a collaborating party, containing this in addition to the payload information.

The clock quality is transmitted in timing marker bits in some interface types in plesiochronic digital hierarchy. In the case of SONET and the synchronous digital hierarchy, the quality of the clock signal is communicated in what is referred to as the SSM byte (synchronization status message).

Since the clock quality of a clock source with which the telecommunication system is synchronized can be variable and a reference clock can

also drop out, at least two reference clocks that are redundant relative to one another are employed for synchronization of telecommunication systems. The drop-out of a reference clock must thereby be recognized by the telecommunication and a switch must then be automatically made to the redundant reference clock.

In order to assure error-free data transmission in a telecommunication system, telecommunication systems exhibit redundancies both in the data traffic as well as in the clock handling. Fundamentally, the line redundancy and the board redundancy must be distinguished. Given the line redundancy, a line that is redundant relative to one line is established. In board redundancy, assemblies that are redundant relative to one another are present.

A distinction must be made between 1+1, 1:1 and 1:N redundancies both in line redundancy as well as in board redundancy. Given 1+1 redundancy, both units that are redundant relative to one another (lines, assemblies) have the same information in the error-free condition. One of the units is thereby selected as active units, whereas the other is on hand ("hot standby").

Given 1:1 redundancy, the two units that are redundant relative to one another carry a non-identical information in the error-free condition. A determination is thereby made as to which of the redundant units transmits or, respectively, processes information having a priority that is higher than the other unit. In case of error of the unit having the higher priority, the operation of the lower-priority unit is interrupted so that the transmission or, respectively, processing of the more important information can be continued. Given 1:N redundancy, one low-priority unit serves N other units.

When a unit such as, for example, an interface card 5, is newly configured, then the operator recites the redundancies that are desired in the telecommunication system. These redundancies are then established with software-controlled or hardware-controlled switch means. Over and above this, the information about the redundancies that have been established are maintained in data banks.

To this end, the telecommunication system has a central data bank available to it wherein data relating to each and every individual reference clock are also maintained in addition to information about the status of individual assemblies,

alarm messages about failed units and the plurality of reference clocks. These clock-specific data comprise the specification of the interface card from which the reference clock and the payload data are taken, the priority, the current quality and the availability of the reference clock as well as alarm messages regarding reference clocks that have dropped out.

In addition to the central data bank, the telecommunication system also has decentralized (local) data banks available to it to which the individual units have access. These decentralized data banks are images of the central data bank but only contain those data that are required for the respective unit. When data in the central data bank are modified, the telecommunication system also updates the decentralized data banks.

Such a modification of the central data bank ensues, for example, when a peripheral processor platform (an interface card, a clock generator) or some other unit fails, the quality of a reference clock changes or a new reference clock is established.

In traditional telecommunication systems, the operator specifies the requested redundancy both for the data traffic as well as for the clock handling upon establishment of a unit such as, for example, an interface card 5.

This has the disadvantage that settings are also possible wherein only the data traffic but not the clock handling is secured due to the presence of redundant units. The case can thereby occur that, given an outage or a reduction in quality of the clock signals, a data traffic becomes faulty due to the shifting of clock frequencies even though redundancies had been established.

The invention is thus based on the object of specifying a method for operating a telecommunication system as well as a telecommunication system having enhanced operating dependability.

This object is achieved by the subject matters of patent claims 1 and 17.

Advantageous developments of the invention are the subject matters of the subclaims.

What is particularly achieved with the invention is that, upon establishment of redundant units (lines, assemblies), redundancies relating both to the data traffic as well as to the clock handling are always established. As a result

thereof, sources of error are avoided and an enhanced failure dependability is achieved.

Further, the invention advantageously creates a method for operating a telecommunication system as well as a telecommunication system wherein the operator need not indicate the redundancy thereof upon establishment of the reference clock. This leading to a reduction of the work outlay. Over and above this, all information about established redundancies are present at the earliest possible point in time via central and decentralized data banks.

Preferred exemplary embodiments of the invention are explained in below. Shown are:

Fig. 1 an overview of clock handling units of an ATM node.

The lines, interface cards 5 and clock generators 3, 4 shown in Fig. 1 can be redundantly operated. Over and above this, further clock handling units can comprise redundancies. Finally, the data traffic units and lines (which are not shown in Fig. 1) also comprise redundancies.

According to the preferred exemplary embodiment, the operator of the telecommunication system establishes a 1+1, 1:N or 1:1 redundancy of a line or of assembly that serves the purpose of data traffic. This redundancy is deposited in a data bank. Subsequently, the redundancy of the data traffic is automatically determined with a software control and applied to the clock handling. To that end, a corresponding redundancy of the clock handling devices is set under hardware control. Subsequently, the redundant units (lines, assemblies) that have been set are established and one of the redundant units is selected for active operation. Queries of the local data bank will preferably ensue for this purpose.

The inventive method is preferably applied in an inventive telecommunication system for establishing a clock source that comprises a 1+1 line redundancy.